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Bone-patch type secondary projectiles: a report on two shots fired at point-blank range using hollow point bullets.*

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Abstract

The number of head wounds due to firearms remains low in France because these cases are primarily linked to suicide (or attempted suicide) and, to a lesser extent, to attacks or hunting accidents [1]. Characterized by the impact of a projectile, which in most cases is made of metal, at high levels of kinetic energy, such acts generally result in severe trans-cerebral lesions with significant levels of morbidity/mortality [2].

Seldom are cases reported in the literature that give a detailed study of intracranial foreign bodies made of bone in such situations [3].

Here we report on the case of two suicides resulting from a transcranial gunshot wounds caused by weapons and ammunition issued by the French police force. Each case helped distinguish a characteristic bone fragment, in the form of a “patch”, equivalent in size to the caliber of the bullet.

Keywords: transcranial wound, secondary projectile, bone-patch, ballistics

1. Introduction

An expanding bullet is one characterized by its potential to open and possibly fragment upon impact, resulting in major tissue damage [4]. Such bullets, made of bare lead or coated with an alloy, are constructed with a hollow tip, which directs the pressure outwards upon impact, causing them to open from the front and increasing their diameter.

As such, an expanding bullet is better at transferring its energy to the soft body it penetrates, and therein lies its advantage, characterized by a) stopping power [the usual definition of which is the ability of a bullet to put an opponent out of action on first impact], b) delivery of its energy to the target and, c) absence of “over-penetration”, or the risk of ending its path in a third-party body located near the shot’s trajectory.

All this implies a substantial lesional potential, most likely to stop an aggressor in their tracks; combined with a successful target hit that is very likely to produce major associated lesions.

Conversely, these same effects reduce the efficiency of such a projectile against ballistic protection, since the increased diameter of the bullet increases its contact surface, against which energy is dissipated.

As regards hollow point bullets, it is also frequently observed that because of their hollow tip, the mere fact of penetrating an obstacle, such as thick clothing, will result in the hollow being filled, thus reducing their expanding effect. Indeed, when such bullets penetrate a flexible covering, the tip becomes weighed down and then behaves like a "standard" bullet.

The SIG Pro semi-automatic pistol, made by Swiss and German manufacturers Swiss Arms AG and Sauer & Sohn is used by the U.S. Drug Enforcement

Administration (DEA), as well as by other law enforcement agencies around the world. In 2003, French police and customs adopted a version of this weapon known as the SP 2022. Weighing in at just under one kilogram, it was the first gun to use polymer materials for its frame. It has a so-called double-trigger system, which means that its security is equivalent to that of the revolver. Its feeder can hold up to 15 cartridges of 9mm Parabellum (.40 S&W).

The Gold Dot regulation issue cartridge made by U.S. manufacturer SPEER (Table 1) consists of a brass case, a Boxer-type primer, double base propellant powder and a lead-core bullet with a copper jacket and a hollow or recessed tip. Its most striking characteristic is that the compression of material in its central channel initially causes a deformation of the front portion ("mushrooming") which increases its nominal diameter, then, due to the effect of tissue resistance, causes its structure to separate, in the form of a “petalization”. The thickness of the jacket gradually increases to ensure better expansion control, ending with a warhead diameter that is generally double the size of the original [5-8].

Table 1

Speer 9mm 124 grain Gold Dot JHP:

Test Gun	Barrel Length	Velocity	Bare Gelatin		Denim Covered Gelatin	
			Penetration	Expansion	Penetration	Expansion
Star M43 Firestar	3.4"	1068 fps	12.6"	0.59"	17.5"	0.51"

Notes: BB calibration velocity 583 fps/penetration 9.8 cm. Penetration and expansion values listed are three shot averages per test event. Denim Shot #3 exited gelatin block after penetrating 16 inches. Penetration depths listed are corrected [MacPherson, Duncan: "A Simplified Penetration Depth Correction for Data Taken in Non-Standard Gelatin," Wound Ballistics Review 2(2): 41-45

1995.]

From an epidemiological perspective, suicidal behavior using firearms in France accounts for a large proportion of suicides and attempted suicides. In fact, in 1999 this type of mortality stood at the rate of 3.4 per 100,000 residents. Firearms thus rank second in terms of suicide methods used by men, after hanging [9]

With 40 to 55 suicides per year among police officers, a figure that is ten times the national average, France is ranked third in terms of OECD police forces who fall victim to such acts. Generally speaking, several risk factors are identified, including divorce, alcohol addiction and occupational instability [10]. Although we did not identify any studies highlighting a link between the profession of police officer and suicide rates, several studies have shown the existence of a positive correlation between the availability of firearms and the rate of suicide via this method (around 50% in the case in point) [11].

Numerous studies on gunshot wounds show that regarding suicide, the head is the main point of entry, and that in terms of handguns, the ipsilateral temple on the dominant side is the preferred target area [12, 13].

Reviewing 65 intracranial shots, M. Faller-Marquardt [3] noted that in five cases, along with entry-level lesions, there were noticeable elements ("small bone plates") located near the entry wound, though no information was provided as to their size, shape or the nature of the projectile responsible for death.

Due to its ability to perforate, in other words to go through barriers and penetrate deep into the target, and its ability to expand within tissues, can the Speer Gold Dot® bullet generate a specific bone fragment in the form of a patch as described above, in the event of a transcranial shot at point-blank range?

We will study the case of two police officers who fell victim to this type of behavior, in an attempt to find an answer.

2. Report on two cases

The two men in question were 43 and 46 years of age, one a policeman and the other an officer; who committed suicide just a few weeks apart using their regulation firearms and ammunition as described above. Both shots were fired at point-blank range in the temporal region, and were transfixial. At the request of the public prosecutor, examinations at the scene and autopsies were performed, preceded by a full body CT scan. After our examinations, and at the magistrate's discretion, only the suicide committed on the service premises (as opposed to the one committed at home) was subject to an additional histopathological study of the brain.

Autopsies

The entry skin lesions are characterized by circular, “cookie cutter”-shaped wounds of 17 and 15 millimeters in diameter, with an abrasive collar and soot deposits on their inner edges (Figs. 1A & 1B).

Fig. 1A: Entry wound, case 1

Fig. 1B: Entry wound, case 2

Dissection revealed an underlying bony opening of diameter 9mm that was perfectly circular, moving a splayed cone shape towards the endocranial aspect, also showing blackish deposits on its inner edges.

Two other parietal wounds on the opposite laterality were noted, with irregular linear edges, one of which was three centimeters long, the other being in the form of three branches, measuring 15 mm long x 10 mm high. We observed the absence of any abrasive collar or soot-type deposits around the edges, giving them the characteristics of shot exit wounds (Figs. 2A & 2B).

Fig. 2A: Exit wound, case 1

Fig. 2B: Exit wound, case 2

As regards lesions, there were stigma relating to ballistic cranial trauma, including hemorrhagic infiltrations to the internal side of the scalp and opposite the temporal muscles, bone shattering along the entire skull vault, and diffuse subarachnoid bleeding. Similarly, there was widespread destruction of the cerebral parenchyma affecting the frontal, parietal and temporal lobes, with damage to both brain stems.

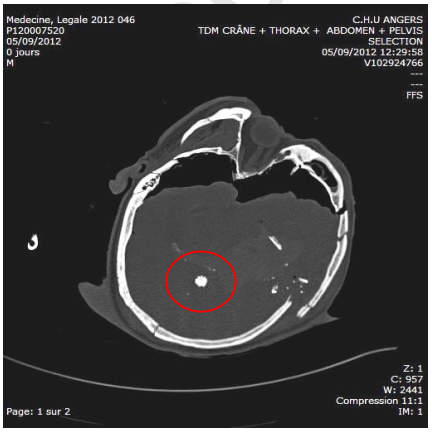
The ballistic trajectory appears consistent with the skin wounds, from right to left, from front to back and with a slight upward tilt. Toxicology analyses were absolutely negative.

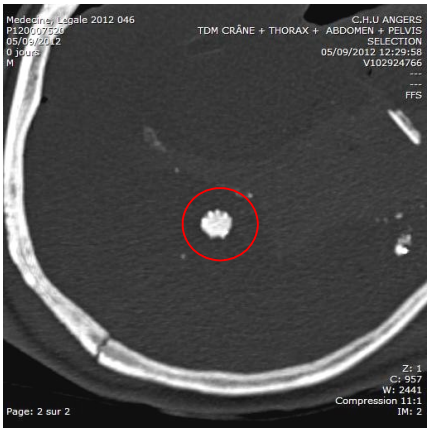
Upon dissection of the subjects' brains, a single bone fragment or "patch" was revealed, which is circular with a diameter of 9mm, and presents triangular blackish microtraces around the edges, on one side only (Fig. 3)

Fig. 3: Bone "patch"

Examination of scans

In addition to assessing the various lesions (fractures, hemorrhages, pneumocephalus), the cerebral scan proves invaluable in forensics thanks to ballistic path analysis, and the ability to study the number and nature of *in corpore* projectiles [14]. Thus, after careful examination of the images, in both cases, the presence was shown of one of the circular bone patches found during the autopsies, representing a secondary bony intracranial projectile (red circle on Figs. 4A, 4B and 5 below).





Figs. 4A & 4B: 2D scan of cranial section showing the "patch"

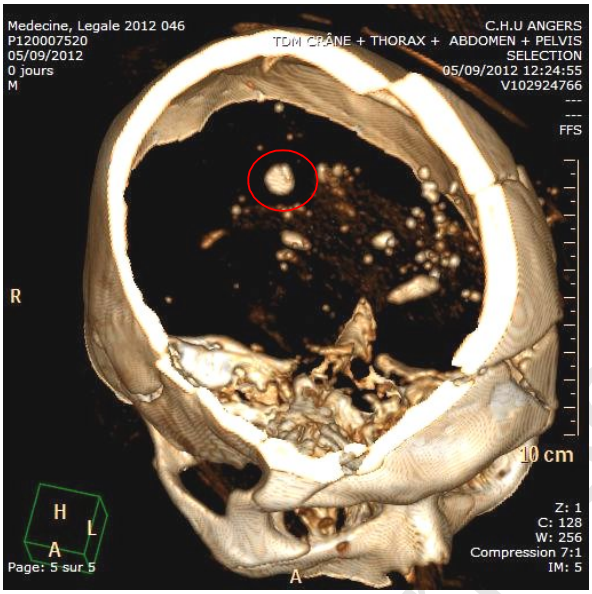


Fig. 5: 3D scan of cranial section showing the “patch”

Examination of one of the projectiles

Both bullets ended their paths in the walls situated close to the victims. We were able to examine only one of these, after the bullet lodged in wall plaster. We observed that the tip of the bullet had expanded as stated by its manufacturer, with a diameter corresponding exactly to the size of the bone patch found inside the skull (Fig. 6). Metal fragments were also embedded in the "bone-patch”, corresponding to the geometry of the projectile tip (Figs. 7 and 8)

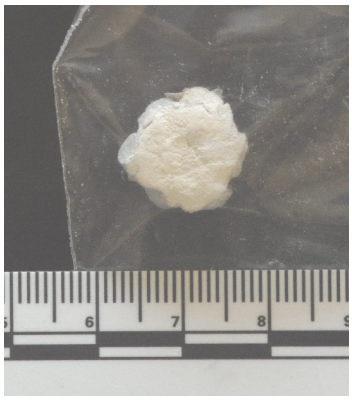


Fig. 6: “Flower”-form projectile found in wall plaster

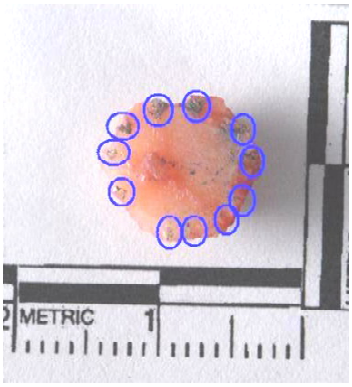


Fig. 7: "Bone-Patch" with metal fragments

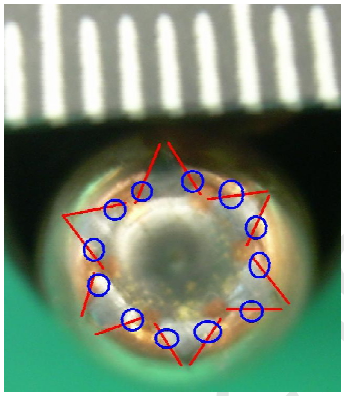


Fig. 8: Hollow-tip projectile

3. Discussion

The description of the bullet's path is an important forensic element in estimating the angle of impact and in deducing the position of the weapon in relation to the victim [15].

The bullet's behavior in biological mediums depends as much on factors specific to the weapon as on the intrinsic dynamic properties of the ammunition, and the physical properties of the surfaces encountered (elasticity, density). Ballistic lesions are caused by a variety of lesional mechanisms [16]: direct laceration by the projectile with tissue damage lasting the length of its path, transmission wave by energy loss of the projectile due to physical restrictions on the adjacent cerebral parenchyma (stretching, shearing, compression) and the phenomenon of temporary cavitation. This combination of parameters means that no physical theory allows us to predict with absolute certainty the behavior of a projectile in the human body.

The route traveled by the bullet is responsible for bone and parenchymal lesions following direct laceration of the parenchyma, as well as subsequent to cavitation and overpressure. This body damage is behind edema-hemorrhagic reorganizations that

enable the ballistic path to be reconstructed. It is more complex and difficult to establish in the event of multiple projectiles or when the bullet ricochets off the bone walls. Topography of the ballistic path also allows a prognosis of survival to be made [1, 17].

The existence of intracranial foreign bodies comes either from the primary projectile (bullet) or from so-called secondary projectiles: bone fragments or metallic debris from the bullet, pieces of clothing or fragments from intermediate targets torn off as the bullet passes by, and so on. Secondary projectiles may also penetrate and cause lesions, and their presence tends to worsen the prognosis, due to an increase in traumatic intracerebral lesions [18, 19].

These two cases, as classically described in the literature, due to the perpendicular incidence of the bullet in relation to the skull, show entry wounds that are typically of the same size as the ammunition caliber (9 mm) with clean edges, and that show splaying towards the internal aspect [20, 21]. In addition, they are associated with many small intracranial bone fragments. Since the bullet did not fragment, it did not create any metal fragments in the form of a "lead snowstorm", in accordance with the literature [5, 8].

We did not find any specific studies on bone fragments following to transcranial shootings. In fact, most articles about gunshot wounds report the concept of scattered bone fragments, often located near and in line with the bullet's path, but they do not go into any further depth. In the study on the post-mortem 3D reconstruction of gunshot wounds to the head [22], O. Peschel confirms, in respect of a homicide case involving Speer Gold Dot ammunition, the existence of bone fragments without providing any further details. Bone elements extracted from the cerebral parenchyma in the form of a patch of 9mm in diameter, marked around the edges by grayish triangular dots, can be clearly distinguished from the other bone fragments, which are smaller in size and are

irregular in outline. Simple comparison with the naked eye reveals that the patch can be superimposed on the expanded tip of the bullet shot. The blackish triangular deposits which border these patches on a single aspect correspond to the junctions between the lead and the sleeve-end in the Speer Gold Dot ammunition.

Finally, a retrospective analysis of radiological CT images with 3D reconstruction sets them apart from other fragments in the "*bony sandstorm"*

4. **Conclusion**

It would thus appear that a transcranial shot fired at point-blank range in the temporal region, made using Speer Gold Dot munition, could be the cause of a secondary bone projectile of the same size as the entry wound itself.

This veritable bone-patch could thus be identified, among the "*storm*" of associated bone fragments, as an indicator of ammunition type, or even of shooting distance.

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